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Abstract

We examine the largest house energy efficiency retrofit support program in Greece that ran during 2011-2015 and approximately fifty thousand households participated. We take advantage of an exogenous change that occurred while the program was running. This change substantially increased the subsidy rate for lower-income households. We find that this effective cost reduction increased the participation rate (extensive margin) and investment amount (intensive margin) of these lower-income households.

Keywords: Energy efficiency retrofits, subsidy, exogenous change, participation rate, household investment.

JEL: Q40, Q48

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1. Introduction

Governments have continuously researching ways to stop climate change and reduce energy dependency on the ever decreasing fossil fuels reserves. The most recent Directive of the EU (2012) set a 20% energy savings by 2020. Within the Directive, one of the main policies proposed is the retrofit of existing houses "such as improving the efficiency of heating systems, installing double glazed windows or insulating roofs".[1] To this end, a number of countries have implemented policy support programs to incentivize home owners to invest in energy efficiency retrofits (EER).[2]

Studies have shown that EERs can potentially reduce energy use and improve public health (Thomson and Thomas 2015; Webber *et al.* 2015). Furthermore, Milne and Boardman (2000) have found that for lower-income household, EERs will increase the average temperature, as the current temperature (14^{o}C) is well below comfort levels, in addition to saving energy. However, numerous policy reports identify that such support programs may not be accessible for lower-income households.[3]

Our objective is to examine whether effective cost reductions in EERs influence the behavior of lower-income households. While the answer may seem intuitive, studies have shown that monetary incentives may not play a significant role in EER investments or the participation rate of support programs (e.g. Fowlie *et al.* 2015). Trotta (2018) cites various even psychological factors influencing household behavior, then he provides evidence that low-income households appear less likely to invest in energy efficient retrofit measures comparing with medium and high-income households. Various studies have examined impacts of different policy schemes; however, there have been though few large-scale ex post evaluations of the actual impacts (Webber *et al.* 2015).

To examine such a question, one would need to find an exogenous change in EER costs. In this paper, we opt for an alternative by examining the largest EER program that took place in Greece and ran between 2011 and 2015 with 50,038 participants.

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[1] https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive

[2] For an overview of house energy efficiency action plans and reports per country, see:
https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/financing-renovations
https://ec.europa.eu/energy/node/84

[3] For the US see Cluett *et al.* 2016, for Europe see Ugarte *et al.* 2016 and Ordonez *et al*. 2017, for Australia see ACOSS (2013).

The aforementioned support program provided financial support for an up to a €15,000 EER budget. A share of the budget was covered by a subsidy, while for the remaining share the program offered an interest-free loan. The unique setting stems from the fact that during the first year of the support program, the income criteria changed and the subsidy rate increased substantially for lower-income households. To this end, we are able to identify the effect an increase in subsidy rate (effective decrease in EER costs) had on lower-income households' EER behavior.

We provide two independent empirical setups to answer the above question. In the first, each participating household is assigned to a zip code; we classify each zip code based on the overall income level. We then examine the aggregate behavior of the zip code before and after the subsidy change. We perform this Difference-in-Differences (Dif-in-Difs, Card and Krueger, 1994) approach by comparing the change between lower-income and higher-income zip codes.

In the second setup, we examine the behavior of households that entered right after the subsidy change but had likely filed with the old subsidy in place and compare it with households' behavior that entered a few months after the policy change and likely filed with the new subsidy in place. The empirical results from this approach reach to similar results as the zip code analysis.

Our first result shows that lower-income households increased their participation once the subsidy increased. We call this the extensive margin[4]; in other words an effective decrease in the EER cost for lower-income households resulted to an increased participation of these households.

Our second result is that lower-income households also increased the investment amount on EERs; we call this the intensive margin. In particular, the average house from a lower-income region increased its budget by 5% more than the average house in higher-income regions. Detailed data on households from the second empirical setup show an even bigger effect. This latter result constitutes a significant contribution of our paper as most studies on EER support programs report findings with respect to the extensive margin while findings with respect to the intensive margin are more scarce.

[4] The terms "extensive" versus "intensive" margin reflect the distinction between whether to invest (extensive) and how much to invest (intensive). The former is typically measured by the number of households entered the programme and the latter by the average investment amount for those that participated. These notions have been largely used in the economics literature (for instance, Blundell *et al.* 2013).

Our paper relates to the rich and informative literature that examines the willingness-to-pay with respect to house energy retrofits. Studies have shown that such retrofits are significantly valued by home owners and tenants (Banfi *et al.* 2008; Grösche and Vance 2009; Kwak *et al.* 2010) while the household's demographic profile plays a significant role in deciding whether to invest in EERs (Das *et al.* 2012). We contribute to this literature by offering casual evidence of whether lower-income households respond to an effective decrease of the EER costs.

While we do not examine how energy use changed after the EERs, our paper also relates to the large literature of the rebound effect. Simply put, the rebound effect occurs when households that invest in EERs end up using more energy than the energy savings predicted; in certain cases, households may end up using the same amount of energy as before in order to enjoy better housing conditions (Greening *et al.* 2000). A large literature has shown that the rebound effect is more prevalent for lower-income households (Ehrhardt-Martinez and Laitner 2010; Chitnis *et al.* 2014; Aydin *et al.* 2017; Fowlie *et al.* 2018). This is an intuitive result given that lower-income households spend disproportionately larger share of their income for energy and heating costs (Bird *et al.* 2012). Coupled with the fact that many of these households live below average levels of warmth, EERs will result to energy savings but also to moderate increases in energy use to attain improved comfort levels to catch-up with middle class living standards and health conditions (Howden-Chapman et al., 2012).. Our paper contributes to this literature by explicitly considering lower-income households' behavior with respect EER cost reductions.

Finally, given that our focus is on Greece, it is useful to discuss why it is an interesting case study. Of all EU member countries, it has arguably been the one hit most by the financial crisis with GDP and income levels decreasing sharply the last decade (Gibson *et al.* 2012). Indeed, Papada and Kaliampakos (2016) in survey of Greek households showed that 58% are energy poor. This can potentially have negative effects to the population's health (Kentikelenis *et al.* 2011) with one such channel being the worsening housing conditions. To make matters worse, Greece ranks very low in energy efficiency across the EU member countries (Makridou *et al.* 2015). [5] Evidence-based studies such as ours can provide insights to policy makers in

[5] Rapanos and Plemis (2006) have also shown that Greece's income elasticity with repect to energy demand is highly elastic. A fiding that can partly be attributed to the inefficiency of the enrgy sector.

Greece as in the foreseeable future, EU will finance more house energy efficiency programs.

The next section describes the Greek household energy efficiency program in detail and the structural break employed in this paper. The following two sections discuss the econometric setup and data. The results section outlines the effect of the increase in subsidy both on the extensive and intensive margin. The robustness section provides the approach and results at the household level. Finally the paper concludes.

2. The Greek Household Energy Efficient Program

On January 13, 2011, the Ministry of Environment, Energy and Climate Change issued a press release launching the “Saving in-house” energy savings program (hereafter the Program). The Program was co-financed by the European Union and its goal was to provide incentives to home owners to engage in EERs. It provided financial support in the form of a subsidy and an interest-free loan for residential buildings and apartments; the loan would be issued by one of the four systemic Greek banks and the Program would pay for the interest amount.

Applications could be submitted on or after February 1, 2011 at any point in time and the households were notified on the award through publicly released lists; these lists were published periodically (every few months). The Program’s first recipients were notified on July 14, 2011 and until March 3, 2012 there were 8 such lists covering 10,248 awarded households.

The Call’s first financial scheme for these aforementioned participant was structured based on income criteria as follows: For single (family) households with incomes below €22,000 (€40,000), the Program would subsidize 35% of the EERs; for single (family) households with incomes between €22,000-€40,000 (€40,000-€60,000), the Program would subsidize 15% of the retrofits. In both cases the rest of the approved budget would be provided in the form of an interest-free loan. Finally, for single (family) households with incomes between €40,000-€60,000 (€60,000-€75,000), the Program would not subsidize any of the retrofits but would cover the interest of a loan in the case the household wished to apply for such a loan. In all cases, the approved retrofit budget could not be larger than €15,000. We denote these income types as A.I, B.I and C.I, respectively. Table 1 shows the income types and their associated subsidy rate. As can clearly be seen, the overwhelming majority (99.3%) of households belonged in the low income category. This overwhelming majority is most likely due to the low or zero amount of subsidy with respect to the rest of the income types. Even a 15% subsidy for the B.I. households may not be appealing when all the hidden costs with respect to EERs are accounted for.[6]

Table 1 goes about here.

On March 12, 2012, roughly eight months after the first households were notified of the support, the Ministry changed the amount of support and income criteria. This change was largely unanticipated as revealed by a cursory review of media outlets. The incentive scheme became effective immediately.

The new scheme was as follows. For single (family) households with incomes below €12,000 (€20,000), the subsidy rate would be 70%; for single (family) households with incomes €12,000-€40,000 (€20,000-€60,000), the subsidy rate would be 35%; for single (family) households with incomes €40,000-€60,000 (€60,000-€80,000), the subsidy rate would be 15%. We denote these income types as A.II, B.II and C.II, respectively. In all cases, the household would receive an interest free loan for the rest of the approved budget which as before could not exceed €15,000. Table 1 displays these ‘new’ income types, their associated subsidy rate and participation rate.

This change in income criteria and support scheme clearly provided a substantial incentive for single (family) households with incomes below €12,000 (€20,000) – A.II income types. Prior to the change, the amount of subsidy was 35% while after the change doubled to 70%. It further provided incentives for middle income households since after the change they would receive a 35% subsidy instead of the prior 15%.

3. Econometric Specifications at the Zip Code Level: The Effect of House Energy Efficiency Costs on the Extensive and Intensive Margin

[6] For instance, Joskow and Marron (1992) found significant transaction costs to utility conservation programs while there are other costs such as search costs for the best price and quality for EERs (Jaffe *et al.* 2004). Fowlie *et al.* (2015) also found significant non-monetary costs associated with participation in EER support programs. For a comprehensive review of all types of hidden costs see Gillingham *et al.* (2009).

Our first question examines whether the increased incentives for lower-income households affected the number of such households entering the Program (extensive margin). The second question examines whether lower-income households that entered the Program after the change invested more in EERs than households that entered before the Program (intensive margin).

In the ideal setup, we would have the income type for each household. Unfortunately, we do not have the exact income information for every household. Therefore, for houses before the change we cannot classify them based on the new income classifications; had we had such information we would be able to examine a counterfactual on these lower-income households by comparing the participation of single (family) households below €12,000 (20,000), in the before and after period.

To this end, we set up an aggregate analysis at the zip code level. [7] The Ministry of Finance, in 2012, published for the first and last (to this date) time the average household income per zip code.[8] Given that for 95% of our observations we have consistent zip code information we can observe the number of households that participated in the Program per zip code and whether the change had an additional effect on the number of houses for lower-income zip codes. In its simplest form the baseline specification is the following:

$$Houses_{i,t} = \alpha_0 + \alpha_1 After_t + \alpha_2 After_t * LowerIncome_i + Zipcode_i + \varepsilon_{it} \quad (1)$$

Where $Houses_{i,t}$ is the number of houses that entered the program in zip code *i* at period *t*. *t* here can take two values corresponding to a before and an after period; i.e. before or after March 12, 2012. $After_t$ takes the value of 1 for the period after the change and 0 for the period before. $LowerIncome_i$ takes the value of 1 for zip codes below a certain income level and 0 otherwise. In certain versions we classify lower-income zip codes as those below the median income level while in other versions as those below the 33[rd] percentile. Finally $Zipcode_i$ is a set of dummy variables for each zip code in the sample.

The coefficient of importance here is that of the interaction. To validate our hypothesis that lower-income regions were more responsive to the added incentives

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[7] We should note that region-level analysis has been performed for similar questions in the literature (e.g. Bradshawa *et al.* 2014).

[8] http://www.gsis.gr/gsis/info/gsis_site/PublicIssue/

we would expect for α_2 to be positive indicating an added effect of the change on the behavior of such regions.

Given that our dependent variable is a count variable, we report results from an unconditional fixed effects Negative Binomial estimation. This way we are able to account for overdispersion in the data (Allison and Waterman, 2002). Finally, we cluster standard errors at the zip code level to account for possible serial correlation (Bertrand et al., 2004)

The second question relates to the intensive margin of house energy efficiency investments. We replace the dependent variable of equation (1) with a variety of different variables to approximate the intensive margin. First, we examine the natural log of the application amount of the average household in each zip code. Second, we examine the natural log of the approved budget of the average household. Third, we consider the share of households within each zip code that filed for a budget higher than the €13,000.[9] Fourth, we consider the share of households within each zip code that were awarded a budget higher than €13,000.

We should note two points with respect to application amount and award amount. First, 65.3% of the households were approved the budget they asked for. Second, 7.3% of the households filed for a budget of more than the maximum allowed of €15,000. This practice was not necessarily a faulty one; a household needed to show the entire retrofit plan even though it knew that only up to €15,000 could be approved.

4. Data

We draw data from two sources. First, the individual level data of each participant are obtained from the Hellenic Fund for Entrepreneurship and Development (HFED).[10] Decisions on awards of the subsidy were published every few months between July 2011 and August of 2015. For each awarded residence we obtained the following variables: zip code, application amount, grant amount and income type.

The second main source is the General Secretariat of Information Systems (GSIS).[11] In 2012 the GSIS published the average family income per zip code for the

[9] The €13,000 amount roughly corresponds to the 66th percentile of the distribution of application amount over all households.
[10] http://www.etean.com.gr/publicpages/NewsAnnouncements4.aspx
[11] http://www.gsis.gr/gsis/info/gsis_site/PublicIssue/

calendar year of 2011. It was the first year that such data were published and have not been updated since.

Overall, we obtained information on all 50,038 houses that were awarded the support. However, right from the outset we excluded 2,147 houses that either lacked zip code information or the zip code was inconsistent (mostly typos).

We aggregated these data at the zip code level and whether the award decision was announced before or after March 12, 2012. From the aggregation we excluded the households that were notified of the support on August 2, 2012 as these households are likely to have filed for the support prior to March 12, 2012 and therefore do not belong in the after group; we discuss this issue further in the Robustness section. Further, given that the funds allocated to the Program were depleted before the end of the Program, we drop all the participants that were notified in 2015 to avoid any censoring issues. With the above two exclusions, we reduce the sample to 44,039 awards. Finally, we drop three outlier zip codes where the average family income is more than €50,000 reducing our final baseline sample for the core analysis to 44,021 households and 992 zip codes where at least one house has participated in the program.

Table 2 goes about here

Based on the 992 zip codes, the median family income is €16,860. Table 2 – Panel A shows that prior to the change, lower-income zip codes had on average 13.3 houses participating while after the change 45.5 indicating a 340% increase. On the other hand the higher-income zip codes participated with 6.4 houses on average before and 23.5 after indicating to a 370% increase. Both of these increases are to be expected as after the change, there were considerably more houses that entered the Program; i.e. of the 44,021 houses, 9,767 entered before the change and 34,254 after the change. Further, from this simple comparison we cannot readily infer whether lower-income zip codes were more responsive to change as we have not captured zip code heterogeneity which we will take into account in the econometric analysis.

Table 2 – Panel B displays summary statistics for the intensive margin. First, we need to note that we drop 2,747 households due to erroneous amount data. [12]

[12] For instance the sum of the total grant amount exceeded the application amount.

Second, for this part of the analysis, we focus only on the zip codes where there is at least one participant before and one after the change. With these exclusions, there are 830 zip codes remaining.

The average house in lower-income zip codes requested for a budget of €11,469 and was awarded €10,196 while after the change the two figures increased by 9.5% and 19%, respectively. On the other hand, the application amount and grant amount for the higher-income zip codes increased by merely 1% and 11%, respectively. We further examine per zip code the share of households that either applied or were awarded more than €13,000. As can be seen lower-income regions increase the shares by fifteen and twenty two percentage units whereas higher-income regions increased by just three and twelve percentage units respectively. These figures show that houses from lower-income regions increased their investments disproportionately more than higher-income zip codes; in other words the subsidy increase had a significant effect on the intensive margin of lower-income households. We examine these changes further in the econometric analysis.

5. Results

Table 3 shows the effect of the Program change on the propensity of zip codes' participation for a series of data specifications by estimating equation (1).

Table 3 goes about here

In Column 1 we observe that after the change all zip codes increased their participation by an average of exp(1.122) = 3.07 times compared to the before period. Further, the zip codes below the median income level participated an additional exp(0.102) = 10% more than zip codes above the median income level as the interaction term *After_x_LowIncomeMedian* shows. Column 2 redefines the low income dummy by considering only the zip codes located below the 33rd percentile. The differential effect is even stronger. In Columns 3 and 4 we further drop the year 2014 to avoid any remaining censoring issues.[13] Results are qualitatively similar.

[13] One zip code is dropped as during the new sample period, no household has participated and therefore is perfectly identified by its associated zip code fixed effect.

The above results show that after the more favorable treatment of lower-income households, zip codes with lower-income increased their participation to the program compared to higher-income zip codes. Therefore, an effective decrease in EER costs induced more households in engaging in such activities.

Table 4 examines the effect of the subsidy rate increase on the intensive margin of EERs.

Table 4 goes about here

Column 1 examines the natural logarithm of the application amount from the average household. The coefficient of *After* shows that the average household from a higher-income region increases its application amount by almost 2% compared to before; however, the coefficient is not significant. The interaction of *After_x_LowIncomeMedian* is however significant and indicates that the average household from a lower-income region increased its requested amount by an additional 8.8%. When in Column 2 we examine the natural logarithm of the awarded amount, the average household from a higher-income region increases its amount by almost 12.1% compared to before. The interaction term of *After_x_LowIncomeMedian* is again significant indicating that there is an additional effect for the lower-income regions. In Columns 3 and 4 we consider the share of households in the zip code that requested and awarded a budget of more than €13,000 respectively. The interaction term of *After_x_LowIncomeMedian* again shows that there is an additional effect for the lower-income regions. In other words, in lower-income regions the share of houses with close to allowable budget that participated in the Program increased substantially more than in the higher-income regions.

In Columns 5-8, we consider the *After_x_LowIncome33rd* interaction term; results are qualitatively similar with the previous columns. Further, in the Appendix we examine zip codes where at least two or three households participated both in the before and after period. Results are qualitatively similar.

6. Robustness. Econometric Specification at the Household Level

As already stated, we cannot classify households that were awarded the support before the change, based on the income levels A.II, B.II, and C.II respectively. However, for a subset of households that were awarded the support after the income criteria change, we can confidently argue that most of these households filed before the change. To provide basis for this argument, we offer a detailed timeline of the Program.

On February 1, 2011 the Ministry welcomed its first applications for the Program. Almost five and a half months later, the first 2,216 recipients were notified via a public announcement (Figure 1). We denote this five and a half month lag as reference lag that could take for an application during the grant process.

On March 12, 2012 the Ministry announced the change of the income criteria and subsidy amounts. The first notification right after the change was on August 2, 2011, five months after the announcement. Given the five and a half month reference lag in addition to any potential backlog, it is reasonable to assume that the overwhelming majority of the applicants awarded the support in August had filed for the Program prior to the announcement but reaped, unknowingly at the time of application, the benefits of the new subsidy scheme. Therefore, for this analysis we can treat the August 2, 2011 recipients as the before group. The second wave of award recipients after the change was on December 3, 2012, nine months after the announcement; thus, most of such recipients were likely to have filed for the program after the announcement. We treat these recipients as the after group and for the following analysis, we focus only on these two groups. The benefit of focusing on these two groups is that because both were awarded after the change, we can have information on the income levels based on the A.II, B.II, C.II classifications.

We have consistent data for 7,743 households – 2,783 and 4,960 for the before and after group respectively. In the group before, lower-income households (A.II) account for 37.7% of the total recipients while in the after group for 60.7%. This simple participation rate difference is consistent with the aforementioned analysis and provides evidence that the lower-income households were responsive to the added subsidy incentives provided in the program.

Formally, we test the effect of the subsidy increase on the extensive margin as follows:

$$LowerIncome_j = \alpha_0 + \alpha_1 After_j + Zipcode_j + \varepsilon_j \qquad (2)$$

Where $LowerIncome_{j,t}$ takes the value of 1 if the j^{th} household is in the A.II income class and 0 otherwise. $After_{j,t}$ takes the value of 1 if the j^{th} household is from the after group (December 2012, 2011 recipients) and 0 if it is from the before group (August 2, 2011 recipients). We also include zip code fixed effects ($Zipcode_j$). The coefficient of interest is α_1; a positive and significant coefficient would show that the share of lower-income recipients is larger for the December 2012, 2011 group than the August 2, 2011 group.

As an estimator we opt for the linear probability model via the use of Ordninary Least Squares. Even though the dependent variable is a dummy, a probit or logit model would be more appropriate; however, the large number of fixed effects makes such estimators less precise (Angrist and Pischke, 2008).

The single estimation in Table 5 shows the results from equation (2). When the household belongs in the after group (December 2012, 2011 recipients), it is 20.5 percentage units more likely be a lower-income (A.II) household. This simple result shows that the subsidy increase affected positively the extensive margin for lower-income households; a result consistent with the aforementioned analysis.

Table 5 goes about here

To test the intensive margin, we estimate the following equation(s):

$$Y_j = \alpha_0 + \alpha_1 After_j + \alpha_2 LowerIncome_j + \alpha_3 After_j * LowerIncome_j \quad + Zipcode_j + \varepsilon_j \tag{3}$$

Y_j can be four different variables. First, we consider the natural log of the requested amount; second, the natural log of the grant amount; fourth a dummy which takes the value of 1 if the household requested for more than €13,000 and 0 otherwise; fourth a dummy which takes the value of 1 if the household was granted more than €13,000 and 0 otherwise. All these four different versions can show the response of lower-income households due to the subsidy change on the intensive margin.

Our focus is on α_3. A positive α_3 shows that lower-income households spent more in the after period in addition to any increased spending from the higher-income households.

Table 6 displays the results. Column 1 shows that higher-income households in the after group requested for 2% less budget as the coefficient of *After* shows. Lower-income households in the before group requested 5% more than higher-income households in the before group as the coefficient to *LowerIncome* shows. Finally, lower-income households after the change requested for 14.4% more budget than what the higher-income households requested. In Column 2 this interaction term is again positive and significant. In Column 3, the interaction term is interpreted as follows: lower-income households in the after group were 10.8% more likely than the higher-income households in the after group to request an amount of more than 13,000. A similar interpretation can be made for Column 4 and the awarded amount.

Table 6 goes about here

There are two significant insights from the above table. First, we observe that lower-income households spend more than higher-income households in the before group as the positive coefficient of *LowerIncome* shows. This result could imply that lower-income households were in greater need for retrofits prior to the enactment of the Program or that their houses were already in a worse shape than the higher-income households' residences.

Second, the interaction term is always positive and significant implying that after the change lower-income households increased their retrofit investments more than higher-income households. This result accords and provides robustness to the intensive margin results from the zip code analysis.

6. Conclusions

Several studies across countries have raised concerns about the house energy efficiency of lower-income households and the potential welfare and energy benefits improved efficiency can have. To this end, studies have examined whether different kinds of incentives can persuade such households into investing in house energy efficiency retrofits. The challenge for an observer, in many occasions, is to pinpoint such incentives' impact due to the lack of exogenous variation.

Our setting is the largest energy efficiency support program in Greece that ran during 2011-2015. We exploited an exogenous and abrupt change that benefited lower-income households by providing a larger subsidy rate than previously. We found that both the participation rate (extensive margin) and the investment amount (intensive margin) increased for such households compared to their higher-income counterparts.

Our policy recommendations are straightforward. Lower-income households in Greece respond to monetary incentives to invest in EERs. While an allocated budget for future support programs may not be infinite policy makers may need to prioritize the types of houses that are less energy efficient and provide additional incentives. Such incentives need not be in the form of subsidies as they could be tax deductions from retrofit constructions.

We should further mention that due to data unavailability we have not discussed the degree of free-ridership for this energy efficiency program. In short free-ridership occurs when households that would invest in EERs even in the absence of support programs (Grösche and Vance 2009). Therefore, it is clear that any efficiency of a support program is diminished by such behavior. Our policy recommendation of tax deductions is influenced by the study of Nauleau (2014) where she found for the case of France that tax deductions had a diminishing effect over time on free-ridership.

Finally, empirical evidence remains to be provided, from a social welfare perspective, whether the increased subsidy reduced energy use sufficiently after the retrofits. Whether there is a rebound effect requires additional data from utility companies; however, such analysis could provide significant insights for policy makers in Greece. We leave this endeavor for future research.

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Figure 1. Timeline of the house energy efficiency program.

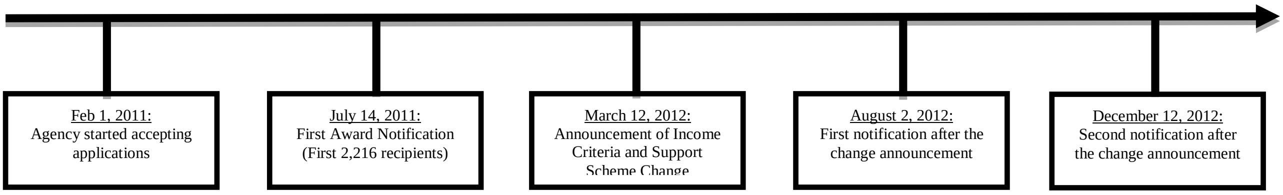

Table 1. Support Schemes by household income type: Before and after subsidy change.

	Type		
	A.I.	B.I.	C.I
Before Change			
Single Income	€0-22,000	€22,000-40,000	€40,000-60,000
Family Income	€0-40,000	€40,000-60,000	€60,000-75,000
Subsidy	35%	15%	0%
Level of Participation (over all households before change)	99.3%	0.7%	0%
	A.II.	B.II.	C.II
After Change:			
Single Income	€0-12,000	€12,000-40,000	€40,000-60,000
Family Income	€0-20,000	€20,000-60,000	€60,000-80,000
Subsidy	70%	35%	15%
Level of Participation (over all households after change)	68.8%	30.7%	0.50%

Table 2. Summary statistics by before and after subsidy change and zip codes

	Before Change	After Change	%Change
Panel A			
Lower-income zip codes	13.3	45.5	340%
Higher-income zip codes	6.4	23.5	370%
Panel B			
Lower-income zip codes			
Average Application Amount	€11,469	€12,560	9.5%
Average Grant Amount	€10,196	€12,161	19%
%of Households that Requested for more than €13,000	0.45	0.61	Fifteen percentage units ↑
%of Households that were Awarded more than €13,000	0.33	0.58	Twenty two percentage units ↑
Higher-income zip codes			
Average Application Amount	€10,251	€10,315	-1%
Average Grant Amount	€8,821	€9,884	12%
%of Households that Requested for more than €13,000	0.35	0.38	Three percentage units↑
%of Households that were Awarded more than €13,000	0.23	0.35	Twelve percentage units↑

Table 3. Effect of income criteria change on the number of households participating in the Program (Extensive Margin). Zip code analysis.

	Dependent Variable: Number of Households			
VARIABLES	(1)	(2)	(3)	(4)
After	1.122***	1.129***	0.989***	0.993***
	(0.0320)	(0.0282)	(0.0327)	(0.0288)
After_x_LowIncomeMedian	0.102**		0.102*	
	(0.0509)		(0.0531)	
After_x_LowIncome33rd		0.145**		0.160**
		(0.0604)		(0.0636)
Observations	1,984	1,984	1,982	1,982
Number of Zip Codes	992	992	991	991
Zip Code FE	YES	YES	YES	YES

Notes: Negative Binomial estimations. *LowIncomeMedian* takes the value of 1 if the zip code's income is below the median and 0 otherwise. *LowIncome33rd* takes the value of 1 if the zip code's income is below the 33rd percentile and 0 otherwise. Standard errors are clustered at the zip code level. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Effect of income criteria change on the investment amount of households participating in the Program (Extensive Margin). Zip code analysis.

VARIABLES	(1) lnAppAmount	(2) lnGAmount	(3) ShareAppMore13K	(4) ShareGMore13K	(5) lnAppAmount	(6) lnGAmount	(7) ShareAppMore13K	(8) ShareGMore13K
After	0.0212	0.121***	0.0299	0.118***	0.0376**	0.134***	0.0528***	0.138***
	(0.0174)	(0.0156)	(0.0191)	(0.0171)	(0.0147)	(0.0134)	(0.0171)	(0.0158)
After_x_LowIncomeMedian	0.0884***	0.0704***	0.136***	0.125***				
	(0.0263)	(0.0243)	(0.0314)	(0.0295)				
After_x_LowIncome33rd					0.0852***	0.0677**	0.139***	0.132***
					(0.0312)	(0.0288)	(0.0375)	(0.0352)
Observations	1,660	1,660	1,660	1,660	1,660	1,660	1,660	1,660
R-squared	0.695	0.741	0.669	0.699	0.693	0.740	0.667	0.698
Number of Zip Codes	830	830	830	830	830	830	830	830
Zip Code FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Ordinary Least Squares estimations. *lnAppAmount* is the natural logarithm of the amount filed of the average house in the zip code. *lnGAmount* is the natural logarithm of the amount awarded of the average house in the zip code. *ShareAppMore13K* is the share of households in the zip code that requested for more than €13,000. *ShareGMore13K* is the share of households in the zip code that were awarded more than €13,000. *LowIncomeMedian* takes the value of 1 if the zip code's income is below the median and 0 otherwise. *LowIncome33rd* takes the value of 1 if the zip code's income is below the 33rd percentile and 0 otherwise. Standard errors are clustered at the zip code level. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Household level analysis. Effect of change on the extensive margin.

VARIABLES	*LowerIncome*
After	0.205***
	(0.0137)
Constant	0.393***
	(0.00879)
Observations	7,743
R-squared	0.203
Number of Zip Codes	778
Zip Code FE	YES

Notes: Ordinary Least Squares estimations. *LowerIncome* takes the value of 1 if the household is in the A.II income class and 0 otherwise. *After* takes the value of 1 if the household is from the after group (December 2012 recipients) and 0 if it from the before group (August 2, 2011 recipients). Standard errors are clustered at the zip code level. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Household level analysis. Effect of change on the intensive margin.

	(1)	(2)	(3)	(4)
VARIABLES	*lnAppAmount*	*lnGAmount*	*AppMore13K*	*GMore13K*
After	-0.0243	-0.0487**	0.00538	-0.0195
	(0.0193)	(0.0197)	(0.0157)	(0.0174)
LowerIncome	0.0541**	0.0566***	0.0635***	0.0658***
	(0.0217)	(0.0215)	(0.0173)	(0.0188)
After_x_LowerIncome	0.144***	0.137***	0.108***	0.113***
	(0.0264)	(0.0264)	(0.0226)	(0.0240)
Observations	7,657	7,657	7,657	7,657
R-squared	0.258	0.250	0.226	0.224
Number of Zip Codes	778	778	778	778
Zip Code FE	YES	YES	YES	YES

Notes: Ordinary Least Squares estimations. *lnAppAmount* is the natural logarithm of the amount filed by the household. *lnGAmount* is the natural logarithm of the amount awarded by the household. *AppMore13K* is a dummy that take the value of 1 if the household requested for more than €13,000. *GMore13K* is a dummy that take the value of 1 if the household was awarded more than €13,000. *LowerIncome* takes the value of 1 if the household is in the A.II income class and 0 otherwise. *After* takes the value of 1 if the household is from the after group (December 2012 recipients) and 0 if it from the before group (August 2, 2011 recipients). *** p<0.01, ** p<0.05, * p<0.1.

Appendix – Robustness at the zip code level for the intensive margin.

Table A.1. Effect of income criteria change on the investment amount of households participating in the Program (Extensive Margin). Zip code analysis. Consider zip codes where at least *two* houses were awarded the support both before and after the change.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	lnAppAmount	lnGAmount	ShareAppMore13K	ShareGMore13K	lnAppAmount	lnGAmount	ShareAppMore13K	ShareGMore13K
After	0.0258	0.129***	0.0270	0.115***	0.0395***	0.139***	0.0483***	0.134***
	(0.0162)	(0.0144)	(0.0167)	(0.0151)	(0.0140)	(0.0125)	(0.0151)	(0.0141)
After_x_LowIncomeMedian	0.0752***	0.0524**	0.129***	0.113***				
	(0.0243)	(0.0219)	(0.0280)	(0.0264)				
After_x_LowIncome33rd					0.0743***	0.0501**	0.136***	0.116***
					(0.0279)	(0.0252)	(0.0338)	(0.0318)
Observations	1,430	1,430	1,430	1,430	1,430	1,430	1,430	1,430
R-squared	0.733	0.786	0.710	0.743	0.732	0.785	0.708	0.741
Number of Zip Codes	715	715	715	715	715	715	715	715
Zip Code FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Ordinary Least Squares estimations. *lnAppAmount* is the natural logarithm of the amount filed of the average house in the zip code. *lnGAmount* is the natural logarithm of the amount awarded of the average house in the zip code. *ShareAppMore13K* is the share of households in the zip code that requested for more than €13,000. *ShareGMore13K* is the share of households in the zip code that were awarded more than €13,000. *LowIncomeMedian* takes the value of 1 if the zip code's income is below the median and 0 otherwise. *LowIncome33rd* takes the value of 1 if the zip code's income is below the 33rd percentile and 0 otherwise. Standard errors are clustered at the zip code level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2. Effect of income criteria change on the investment amount of households participating in the Program (Extensive Margin). Zip code analysis. Consider zip codes where at least *three* houses were awarded the support both before and after the change.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	lnAppAmount	lnGAmount	ShareAppMore13K	ShareGMore13K	lnAppAmount	lnGAmount	ShareAppMore13K	ShareGMore13K
After	0.0375**	0.137***	0.0329**	0.107***	0.0476***	0.144***	0.0506***	0.125***
	(0.0157)	(0.0142)	(0.0157)	(0.0145)	(0.0138)	(0.0124)	(0.0144)	(0.0135)
After_x_LowIncomeMedian	0.0702***	0.0487**	0.122***	0.112***				
	(0.0234)	(0.0212)	(0.0276)	(0.0258)				
After_x_LowIncome33rd					0.0779***	0.0531**	0.135***	0.115***
					(0.0257)	(0.0235)	(0.0338)	(0.0314)
Observations	1,226	1,226	1,226	1,226	1,226	1,226	1,226	1,226
R-squared	0.760	0.811	0.725	0.761	0.760	0.810	0.723	0.758
Number of Zip Codes	613	613	613	613	613	613	613	613
Zip Code FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Ordinary Least Squares estimations. *lnAppAmount* is the natural logarithm of the amount filed of the average house in the zip code. *lnGAmount* is the natural logarithm of the amount awarded of the average house in the zip code. *ShareAppMore13K* is the share of households in the zip code that requested for more than €13,000. *ShareGMore13K* is the share of households in the zip code that were awarded more than €13,000. *LowIncomeMedian* takes the value of 1 if the zip code's income is below the median and 0 otherwise. *LowIncome33rd* takes the value of 1 if the zip code's income is below the 33rd percentile and 0 otherwise. Standard errors are clustered at the zip code level. *** p<0.01, ** p<0.05, * p<0.1.